UCRL-JC-124240 Abs

Streak Camera Power Measurements for Large-Aperture, High-Power Laser Beams*

R. A. Lerche, R. B. Ehrlich, C. W. Laumann, J. L. Miller
Lawrence Livermore National Laboratory
P. O. Box 5508, Livermore, CA 94550

Abstract

Inertial confinement fusion (ICF) research requires good power balance between laser beams irradiating millimeter-size targets. Nova, a powerful ten-beam laser facility, is capable of producing more than 80 KJ of 1.05-µm light and delivering 30 KJ of 0.351-µm light to a target in shaped pulses 1 to 4 ns long. The power range within a pulse, which we call the contrast ratio, can be as large as 40 to 1. Precision target experiments require a beam-to-beam power balance of 5% throughout the laser pulse.

At Nova, power measurements for each laser beam are made by sampling a portion of the beam with two instruments. A calorimeter records the total beam energy for a pulse while a streak camera records the temporal history and synchronization. Instantaneous beam power is obtained by normalizing the integral of the temporal pulse to the measured pulse energy. This paper describes the streak camera systems: beam sampling, signal transport from sampling point to streak camera, and optimization of signal-to-noise ratio.

We use four streak cameras to record beam power history. Each camera operates as a high-speed, multichannel transient recorder, recording data for five beams. Two cameras have S-1 photocathodes and record temporal histories for the incident 1.05-µm beams, the other two cameras have S-20 photocathodes and record temporal histories for the frequency-converted 0.351-µm light. Recent system configuration changes have improved beam sampling and energy transport to the streak cameras, and have improved signal quality and dynamic range. The 1.05- and 0.351-um streak camera measurements use similar techniques, but actual implementation details for beam sampling and signal transport are, however, somewhat different. In both cases, energy sampled from the entire 70-cm beam aperture is directed to a bundle of (~20) precision-cut graded index optical fibers for transport between the sampling point and the streak camera. The increased cross-sectional area of the fiber bundles improves sampling, reduces effects of speckle pattern motion, and improves signal spatial profiles at the streak camera photocathode

The streak camera end of each fiber bundle is coupled to a short light guide. The guides are a few centimeters long and have cross-sectional areas of a few square millimeters. Light from the fiber bundles mixes along the light guide to produce a relatively uniform illumination at the output surface which is placed at the slit plane of a streak camera. A signal imaged from a light guide to a streak camera photocathode produces an image with an excellent fill factor and well defined channel boundaries. Streak camera parameters such as slit width, intensifier gain, and signal area have been adjusted for optimum performance. This paper includes streak camera images and signal lineouts that show the quality of the recorded signals.

*This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract No.W-7405-Eng-48.